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Data Paper

# Fauna Europaea: Coleoptera 2 (excl. series Elateriformia, Scarabaeiformia, Staphyliniformia and superfamily Curculionoidea)

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## Abstract

Fauna Europaea provides a public web-service with an index of scientific names (including synonyms) of all living European land and freshwater animals, their geographical distribution at country level (up to the Urals, excluding the Caucasus region), and some additional information. The Fauna Europaea project covers about 230,000 taxonomic names, including 130,000 accepted species and 14,000 accepted subspecies, which is much more than the originally projected number of 100,000 species. This represents a huge effort by more than 400 contributing specialists throughout Europe and is a unique (standard) reference suitable for many users in science, government, industry, nature conservation and education.

Coleoptera represent a huge assemblage of holometabolous insects, including as a whole more than 200 recognized families and some 400,000 described species worldwide. Basic information is summarized on their biology, ecology, economic relevance, and estimated number of undescribed species worldwide. Little less than 30,000 species are listed from Europe. The Coleoptera 2 section of the Fauna Europaea database (Archostemata, Myxophaga, Adephaga and Polyphaga excl. the series Elateriformia, Scarabaeiformia,

Staphyliniformia and the superfamily Curculionoidea) encompasses 80 families (according to the previously accepted family-level systematic framework) and approximately 13,000 species. Tabulations included a complete list of the families dealt with, the number of species in each, the names of all involved specialists, and, when possible, an estimate of the gaps in terms of total number of species at an European level. A list of some recent useful references is appended. Most families included in the Coleoptera 2 Section have been updated in the most recent release of the Fauna Europaea index, or are ready to be updated as soon as the FaEu data management environment completes its migration from Zoological Museum Amsterdam to Berlin Museum für Naturkunde.

## Keywords

Biodiversity Informatics, Coleoptera, Fauna Europaea, Taxonomic indexing.

## Introduction

In 1998 the European Commission published the European Community Biodiversity Strategy, providing a framework for the development of Community policies and instruments to comply with the Convention on Biological Diversity. The Strategy recognises the current incomplete state of knowledge at all levels concerning biodiversity, which is a constraint on the successful implementation of the Convention. *Fauna Europaea* contributes to this Strategy by supporting one of the main themes: to identify and catalogue the components of European biodiversity into a database to serve as a basic tool for science and conservation policies. In regard to biodiversity in Europe, science and policies depend on the knowledge of its components. Biodiversity assessments, monitoring changes, sustainable exploitation of biodiversity, and much legislative work depend upon a validated overview of taxonomic biodiversity, in which *Fauna Europaea* plays a major role, providing a web-based information infrastructure with an index of scientific names (including important synonyms) of all living European land and freshwater animals, their geographical distribution at country level and some additional optional information (like references and species annotations). Thus the Fauna Europaea database provides a unique reference for many user-groups such as scientists, governments, industries, conservation communities and educational programs.

Fauna Europaea (FaEu) began in 2000 as an EC-FP5 four year project, delivering its first release in 2004 (de Jong et al. 2014). After thirteen years of steady progress to efficiently disseminate Fauna Europaea results and to increase the acknowledgement of the Fauna Europaea contributors, novel e-Publishing tools have been applied to prepare data papers of all major taxonomic groups (see below).

Most families included in the Coleoptera 2 Section (ca. 13,000 species) have been updated in the most recent release of the Fauna Europaea index, or are ready to be updated as soon as the FaEu data management environment completes its migration from Zoological

Museum, Amsterdam to Berlin Museum für Naturkunde. Adopted systematics follows that used in the first release of the database (2004). Recent changes in family-level systematics of beetles introduced by Bouchard et al. 2011 (although not all were accepted by specialists) are foreseen to be implemented as soon as the FaEu data management environment completes its migration. For example, in *Fauna Europaea* the classic treatment of Chrysomelidae Galerucinae and Alticinae as separate subfamilies was used instead of the current view of Alticini as a tribe in Galerucinae, and the current families Megalopodidae and Orsodacnidae are not used, the European species being listed in subfamilies Zeugophorinae and Orsodacninae. The same is true for some other families which changed for different reasons their present-day taxonomic rank (e.g., Anobiidae vs. Ptinidae, Carabidae Rhysodinae vs. Rhysodidae, etc.).

## Data-papers & gap-analysis

To improve the dissemination and citation of Fauna Europaea and to increase the acknowledgement of the Fauna Europaea contributors, a special Biodiversity Data Journal (BDJ) Series has been compiled, using novel e-Publishing tools, called Contributions on Fauna Europaea, preparing data-papers of all major Fauna Europaea taxonomic groups. This work was initiated during the ViBRANT project and is further supported by the recently started EU BON project. This paper represents the first publication of the Fauna Europaea Coleoptera (excl. Elateriformia, Scarabaeiformia, Staphyliniformia) data sector as a BDJ data paper.

Further steps will be made on implementing Fauna Europaea in the EU BON project as a basic tool and standard reference for biodiversity research in Europe, and to evaluate the status of European taxonomic expertise. The Fauna Europaea data-papers will contribute to a quality assessment on biodiversity data by providing estimates on gaps in taxonomic information and knowledge (see Table 1).

Table 1.
Responsible specialists per family in Coleoptera

| FAMILY | NUMBER OF SPECIES IN FAEU (in case of estimated gaps: potential numbers in brackets) | SPECIALIST(S) |
|---|---|---|
| Acanthocnemidae | 1 | Gianfranco Liberti |
| Aderidae | 27 | Gianluca Nardi |
| Alexiidae | 32 (≈ 40) | Wioletta K. Tomaszewska |
| Anobiidae | 419 (≈ 430) | Petr Zahradnik |
| Anthicidae | 314 | Gianluca Nardi |
| Biphyllidae | 5 | Josef Jelínek (resigned) |
| Boridae | 1 | Xavier Vazquez-Albalate |

| | | |
|---|---|---|
| Bostrichidae | 42 (≈ 45) | Gianluca Nardi |
| Bothrideridae | 106 (≈120) | Adam Slipinski |
| Byturidae | 3 | Josef Jelínek (resigned) |
| Carabidae | 3738 (≈ 3900) | Augusto Vigna Taglianti |
| Cerambycidae | 677 (≈ 680) | Gianfranco Sama |
| Cerylonidae | 14 | Adam Slipinski |
| Chrysomelidae | 1758 (≈ 1800) | Maurizio Biondi, Ron Beenen, Michael Schmitt, Renato Regalin, David Sassi, Stefano Zoia, Horst Kippenberg & Marcello Franco Zampetti |
| Ciidae | 76 (≈ 80) | Josef Jelínek & Paolo Audisio |
| Clambidae | 22 | Ivan Löbl |
| Cleridae | 68 (≈ 70) | Roland Gerstmeier |
| Coccinellidae | 215 (≈ 220) | Claudio Canepari |
| Corylophidae | 37 (≈ 40) | Paolo Audisio |
| Crowsoniellidae | 1 | Paolo Audisio |
| Cryptophagidae | 257 (≈ 260) | Carlos Otero |
| Cucujidae | 6 (≈ 8) | Adam Slipinski |
| Cybocephalidae | 26 (≈ 30) | Josef Jelínek & Paolo Audisio |
| Dascillidae | 381 (390) | Manfred Jäch |
| Dermestidae | 197 (≈ 200) | Roustem D. Zhantiev |
| Derodontidae | 5 | Jirí Háva |
| Dytiscidae | 375 (≈ 400) | Anders Nilsson (first release), Saverio Rocchi & Fabio Cianferoni (future updating) |
| Endecatomidae | 1 | Gianluca Nardi |
| Endomychidae | 79 (≈ 80) | Wioletta K. Tomaszewska |
| Erotylidae | 29 | Piotr Wegrzynowicz |
| Eucinetidae | 8 | Paolo Audisio |
| Gietellidae | 2 | Gianfranco Liberti |
| Gyrinidae | 17 | Paolo Mazzoldi |
| Haliplidae | 34 | Saverio Rocchi & Fabio Cianferoni |
| Hydroscaphidae | 2 | Ivan Löbl |
| Hygrobiidae | 1 | Anders Nilsson (first release), Saverio Rocchi & Fabio Cianferoni (future updating) |

| | | |
|---|---|---|
| Jacobsoniidae | 2 | Ivan Löbl |
| Kateretidae | 29 (30) | Paolo Audisio & Josef Jelínek |
| Laemophloeidae | 29 | Adam Slipinski |
| Languriidae | 14 | Piotr Wegrzynowicz |
| Latridiidae | 192 (≈ 200) | Wolfgang H. Rucker |
| Lyctidae | 13 | Gianluca Nardi |
| Lymexylidae | 3 | Paolo Audisio |
| Malachiidae | 327 (≈ 330) | Robert Constantin |
| Melandryidae | 53 | Nikolai Nikitsky |
| Meloidae | 181 (≈ 185) | Marco Alberto Bologna |
| Melyridae | 18 | Gianfranco Liberti |
| Micromalthidae | 1 | Paolo Audisio |
| Monotomidae | 34 | Josef Jelínek & Paolo Audisio |
| Mordellidae | 256 (≈ 270) | Jan Horak |
| Mycetophagidae | 31 | Nikolai Nikitsky |
| Mycteridae | 3 | Paolo Audisio |
| Nitidulidae | 248 (≈ 250) | Paolo Audisio & Josef Jelínek |
| Nosodendridae | 1 | Jiri Hava |
| Noteridae | 4 | Anders Nilsson (first release), Saverio Rocchi & Fabio Cianferoni (future updating) |
| Oedemeridae | 93 (≈ 95) | Xavier Vazquez-Albalate |
| Passandridae | 1 | Adam Slipinski |
| Phalacridae | 56 | Zdenek Svec |
| Phloeostichidae | 1 | Adam Slipinski |
| Phloiophilidae | 1 | Gianfranco Liberti |
| Prionoceridae | 1 | Gianfranco Liberti |
| Prostomidae | 1 | Paolo Audisio |
| Pyrochroidae | 9 | Gianluca Nardi |
| Pythidae | 5 | Xavier Vazquez-Albalate |
| Rhipiceridae | 2 | David Kral |
| Ripiphoridae | 17 | Federica Turco & Marco Alberto Bologna |
| Salpingidae | 19 | Xavier Vazquez-Albalate |

| | | |
|---|---|---|
| Scirtidae | 94 | Maciej Sapiejewski (deceased), proposed follow-up Rafal Rita |
| Scraptiidae | 102 (≈ 110) | Jan Horak |
| Silvanidae | 40 | Adam Slipinski |
| Sphaeriusidae | 3 | Ivan Lobl |
| Sphindidae | 4 | Josef Jelínek (resigned) |
| Stenotrachelidae | 2 | Paolo Audisio |
| Tenebrionidae | 1392 (≈1400) | Simone Fattorini |
| Tetratomidae | 10 | Nikolai Nikitsky |
| Thanerocleridae | 1 | Roland Gerstmeier |
| Trachypachidae | 1 | Saverio Rocchi & Fabio Cianferoni |
| Trogossitidae | 25 | Jan Kolibac |
| Zopheridae | 128 (≈ 130) | Adam Slipinski |

## General description

**Purpose:** Fauna Europaea is a database of the scientific names and distribution of all living, currently known multicellular European land and fresh-water animal species assembled by a large network of experts. An extended description of the Fauna Europaea project can be found in de Jong et al. 2014. A summary is given in the sections below.

Coleoptera is the largest of the 58 *Fauna Europaea* major taxonomic groups, covering nearly 29,000 species in Europe [its Coleoptera 2 Section includes > 13,000 species (Fig. 1) and is represented by a network of more than 40 specialists (Table 1)].

**Addititional information: Coleoptera** [Group Coordinators: Paolo Audisio (Coleoptera 2), Miguel Angel Alonso-Zarazaga (Coleoptera 1)]

Coleoptera are the most diverse order of all living animals, and comprise between 360,000 and 400,000 named species worldwide (Chapman 2009; Slipinski et al. 2011; Zhang 2013; Audisio unpublished data), some 100,000 in the Palaearctic Region, and nearly 30,000 in European-Mediterranean areas. Beetles are the dominating insect group in all terrestrial environments, with the single exception of freshwater habitats, where Diptera are represented by a markedly larger number of species. Even using a conservative estimate, there are likely one to three million beetle species on the Earth. Coleoptera are ecologically diverse (Crowson 1981). Most members of the largest 'basal' suborder, Adephaga, are predatory in both the larval and imaginal stage, while most members of the huge suborder Polyphaga are phytosaprophagous, mycetophagous, predaceous, phytophagous, or xylophagous. The 'basal' suborder Archostemata is represented by a small number of

families and species, mostly distributed in tropical areas, and usually associated with saproxylic habitats. The only known W Palaearctic autochtonous species, *Crowsoniella relicta* Pace from central Italy, exhibits an unknown biology, but it was collected, only once, in hypogeous habitats among tree roots, in carbonatic soils (Ge et al. 2011). In the suborder Adephaga, the largest family is represented by Carabidae, almost all of them having a predaceous life style in terrestrial habitats (relatively few species are seed-eating or myrmecophilous), while other families (e.g., Dytiscidae) inhabit freshwater habitats, where they are mostly predators of other aquatic organisms, only the family Haliplidae includes phytophagous species. The problematic suborder Myxophaga, recently considered questionable from a phylogenetic point of view (Beutel and Haas 2000; Friedrich et al. 2009), is represented by relatively few species mostly associated with mud and wet habitats, chiefly in thermal localities. The huge suborder Polyphaga (including about 90% of Coleoptera worldwide) is a large assemblage of families where both adults and larvae exhibit very diverse life styles. Among members of the large 'basal' superfamily Staphylinoidea, there is a prevalence of predaceous beetles. About one-fifth of Staphylinidae however can be characterized as mycetophagous or saprophagous. A smaller part of them (about 10% of European species) may be characterized as phytophagous or myrmecophilous. Most Staphylinoidea are terrestrial, but in a few families (e.g., Hydraenidae) nearly all species are adapted to an aquatic or semi-aquatic life style, even in very peculiar habitats such as hyperhaline marine rock-pools (Antonini et al. 2010; Audisio et al. 2010; Sabatelli et al. 2013). Most Elateroidea are predators, xylosaprophagous, or xylophagous. Cucujoidea are a large and highly diverse superfamily including species which are mostly saprophagous, mycetophagous, predaceous, phytophagous, or xylophagous, with a few families (e.g., Meloidae, Ripiphoridae) known as specialized parasitoids of other insects (Bologna 1991; Bologna et al. 2008; Bologna et al. 2010; Bologna and Di Giulio 2011; Lawrence et al. 2010). Scarabaeoidea include thousands of species mostly associated with dung of vertebrates, or having rhyzophagous or xylosaprophagous larvae, whereas adults are mostly floricolous. Chrysomeloidea include thousands of species within the main families Chrysomelidae and Cerambycidae, mostly phyllophagous and/or floricolous, or with xylophagous larvae (Biondi et al. 2013;Bouchard et al. 2009). Finally, the most speciose superfamily Curculionoidea, feeding on various plant matter, includes many important pests of cultivated crops and forest habitats as well as some important biological control agents of invasive weeds too (e.g., Ceutorhynchini) (Alonso-Zarazaga and Lyal 1999; Oberprieler et al. 2007). About 29,000 species of Coleoptera are listed for Europe (including more than 4,000 Adephaga, and little less than 25,000 Polyphaga); the taxonomic composition of this fauna is far better known than that of any other major region. But the species numbers occurring in the Afrotropical, Indo-Malayan and Neotropical regions are markedly higher, each of them with an estimated number of 70-90,000 named species. Most families of Coleoptera (at least in the largest suborder Polyphaga) are, in fact, largely represented in tropical and subtropical countries. However, the number of species annually added to the European beetle fauna (including autochthonous species new to Science, or firstly discovered in Europe) is relatively constant over time, while the introduction of alien species is continuously increasing, chiefly among the guilds associated with fruit, timber, stored and cultivated products, and ornamental plants (DAISIE 2008). The species accumulation curve, as in

other large groups of insects such as Diptera, shows no signs of levelling off (Fontaine et al. 2012; Audisio unpublished data). Among the Adephaga, the most species rich families in the European fauna are Carabidae and Dytiscidae, with nearly 3,800 and 400 species respectively. Among the Polyphaga, the most species rich families in the European fauna are Staphylinidae s.l. (ca. 6,000 species), Curculionidae (> 4,500 species), Chrysomelidae (ca. 1,700 species), Tenebrionidae (> 1,400 species), Leiodidae (ca. 1,200 species), Elateridae and Cerambycidae (ca. 700 species each), Cantharidae (> 500 species), Dytiscidae, Hydraenidae, and Buprestidae (> 400 species each). Much remains certainly to be discovered, because especially Curculionidae, Staphylinidae and some small groups (such as, e.g., Bothrideridae, Alexiidae) were poorly studied by modern taxonomists and are much more diverse than suggested by their current count. Coleoptera are among the most important agricultural pests, attacking all parts of living plants as well as stored products such as woody matter, processed fibers and grains (BUSS and Fasulo 2006). Some of them are among the most serious pests of of beehives (Marini et al. 2013), while other groups are active predators or parasitoids (e.g., Carabidae, Coccinellidae, Meloidae, Cleridae) and play a fundamental role in both natural and cultivated environments, as important biological controllers that regulate the number of aphids, scale insects, wood borer species and locusts. On the other hand, beetles are active decomposers and play a major role in recycling organic waste, chiefly vertebrate dung and carcasses, decaying fruit, fungi and dead wood in forest habitats. Many beetles are, in fact, saproxylic, and are considered excellent indicators of woodland quality (Speight 1989; Nieto and Alexander 2010), several being well-known indicators of old-growth forests. Some flagship- and/or umbrella-species of forest habitats are recognized among the large-sized Lucanidae, Cetoniidae, Cerambycidae, and Cucujidae, which also are target species for biodiversity conservation efforts, and priority species included in annexes II and IV of the EU Habitat Directive. Some of them, like the rare but popular *Osmoderma eremita*, drives most of the European and local policies on invertebrate conservation biology and forest management (Chiari et al. 2013, Chiari et al. 2014). Other beetles are excellent indicators of quality (Trizzino et al. 2013), and several studies have been aimed to the use of this group as a tool for river quality assessment, for the management of lotic ecosystems (Trizzino et al. 2015), and for the evaluation/prediction of Climate Change's effects. Finally, the use of certain groups of terrestrial Coleoptera such as ground beetles (Carabidae) and darkling beetles (Tenebrionidae) in the evaluation of the biological quality of the soil is covered by a vast literature (Kotze et al. 2011).

Several species among those in Coleoptera 2 Section have been also included in European Red Lists, such as the recent (although markedly incomplete) IUCN Saproxylic Beetles Red List of Neto & Alexander (Nieto and Alexander 2010). A number of other national, local, and European red lists have been recently published or are in preparation, and the role of *Fauna Europaea* as a standard reference for all these initiatives is more and more evident. The same is true for a number of pest species, quarantine species, and alien species (chiefly in Nitidulidae, Chrysomelidae, Coccinellidae, Cryptophagidae, Cerambycidae, Curculionidae, and others), whose introduction into Europe, as discussed above, is continuously increasing (Buss and Fasulo 2006; DAISIE 2008; Baviera and Audisio 2014; Audisio et al. 2014).

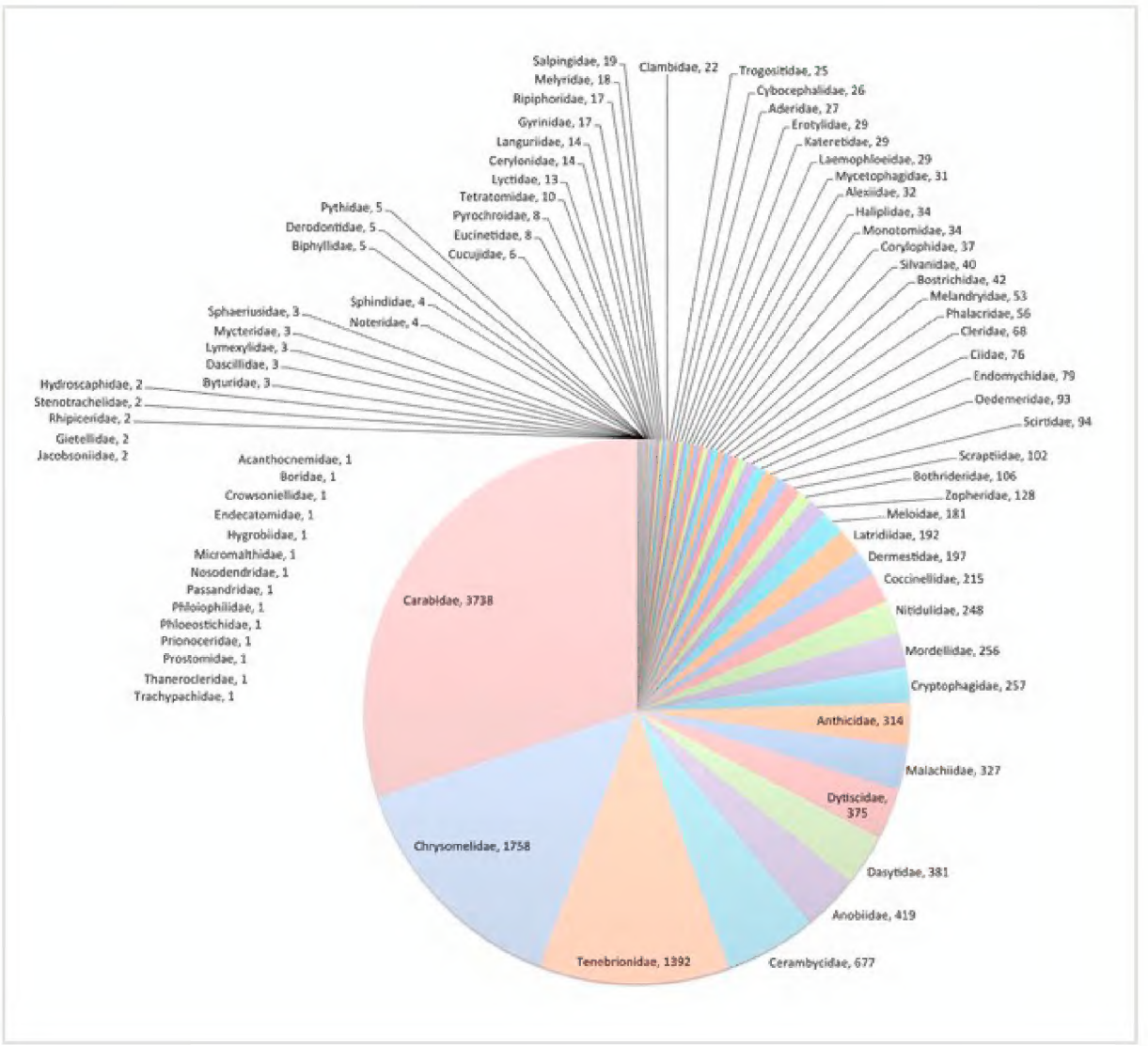


Figure 1.

FaEu Coleoptera species per family. See Table 1 for family statistics. For full resolution see Suppl. material 1.

As shown in Table 1, the taxonomic coverage of Coleoptera 2 Section of the FaEu database is generally good, with few remaining gaps (most of them should be filled in the next upcoming phase of data base updating, probably in Summer 2015). However, certain groups like Ciidae, Cybocephalidae, Cryptophagidae, Bothrideridae, Scraptiidae, and Mordellidae, need the activity of a larger number of specialists both in the field and in museum collections, in order to significantly improve our present-day knowledge in taxonomy and distribution, chiefly in the most potentially species-rich countries of southern Europe. Among the specialists' network, almost all explicitly or implicitly confirmed their participation to the project, although financial support to the project was interrupted some ten years ago. Only a couple of specialists resigned (e.g. in Hydroadephaga) and were replaced during the running activity of file updating, or have recently received the aid of "new" specialists and cooperators of the Group Coordinator PA. Generally speaking, the European network of specialists involved in the Coleoptera 2 Section of the *Fauna Europaea* Project seems to be relatively consolidated, and open to new (welcome) entries, although there is evidence that in most recent years the European beetle taxonomy community, chiefly at a professional level, has been going through a significant "crisis of vocations", only partially and insufficiently facilitated by the scientific support of a lot of (mostly not young) amateur entomologists (Fontaine et al. 2012). A more extensive and

better addressed public financial support, at both European and local levels, should be foreseen in the next years, to prevent the risk of a future dramatic "taxonomic impediment" in the scientific management of European insect biodiversity.

## Project description

**Title:** This BDJ data paper includes the taxonomic indexing efforts in Fauna Europaea on European Coleoptera covering the first two versions of Fauna Europaea worked on between 2000 and 2013 (up to version 2.6).

**Personel:** The taxonomic framework of Fauna Europaea includes partner institutes, providing taxonomic expertise and information, and expert networks maintaining data collation.

Every taxonomic group is covered by at least one Group Coordinator responsible for the supervision and integrated input of taxonomic and distributional data of a particular group. For Coleoptera 2 the responsible Group Coordinator is Paolo Audisio (versions 1 & 2).

The Fauna Europaea checklist would not have reached its current level of completion without the input from several groups of specialists. The formal responsibility of collating and delivering the data of relevant families has resided with the below appointed Taxonomic Specialists (see Table 1), while Associate Specialists deserve credit for their important contributions at various levels, including particular geographic regions or (across) taxonomic groups.

Data management tasks are taken care primarily by the Fauna Europaea project bureau. During the project phase (until 2004) a network of principal partners managed the diverse management tasks: Zoological Museum Amsterdam (general management & system development), Zoological Museum of Copenhagen (data collation), National Museum of Natural History in Paris (data validation) and Museum and Institute of Zoology in Warsaw (NAS extension). Since the formal project ending (2004-2013) all tasks have been taken over by the Zoological Museum Amsterdam.

**Study area description:** The area studied (Fig. 2) covers the European mainland (Western Palearctic), including the Macaronesian islands, excluding the Caucasus, Turkey, Arabian Peninsula and Northern Africa.

**Design description:** Standards. Group coordinators and taxonomic specialists deliver the (sub)species names according to strict standards. The names provided by FaEu are scientific names. The taxonomic scope includes issues like, (1) the definition of criteria used to identify the accepted species-group taxa, (2) the hierarchy (classification scheme) for the accommodation of all accepted species and (3), relevant synonyms, and (4) the correct nomenclature. The Fauna Europaea 'Guidelines for Group Coordinators and Taxonomic Specialists', include the standards, protocols, scope, and limits that provide the instructions for all more then 400 specialists contributing to the project.

Figure 2.

Fauna Europaea geographic coverage ('minimal Europe').

Data management. The data records could either be entered offline into a preformatted MS-Excel worksheet or directly into the Fauna Europaea transaction database using an online browser interface (see: Fig. 3). Since 2013, the data servers are hosted at the Museum für Naturkunde in Berlin.

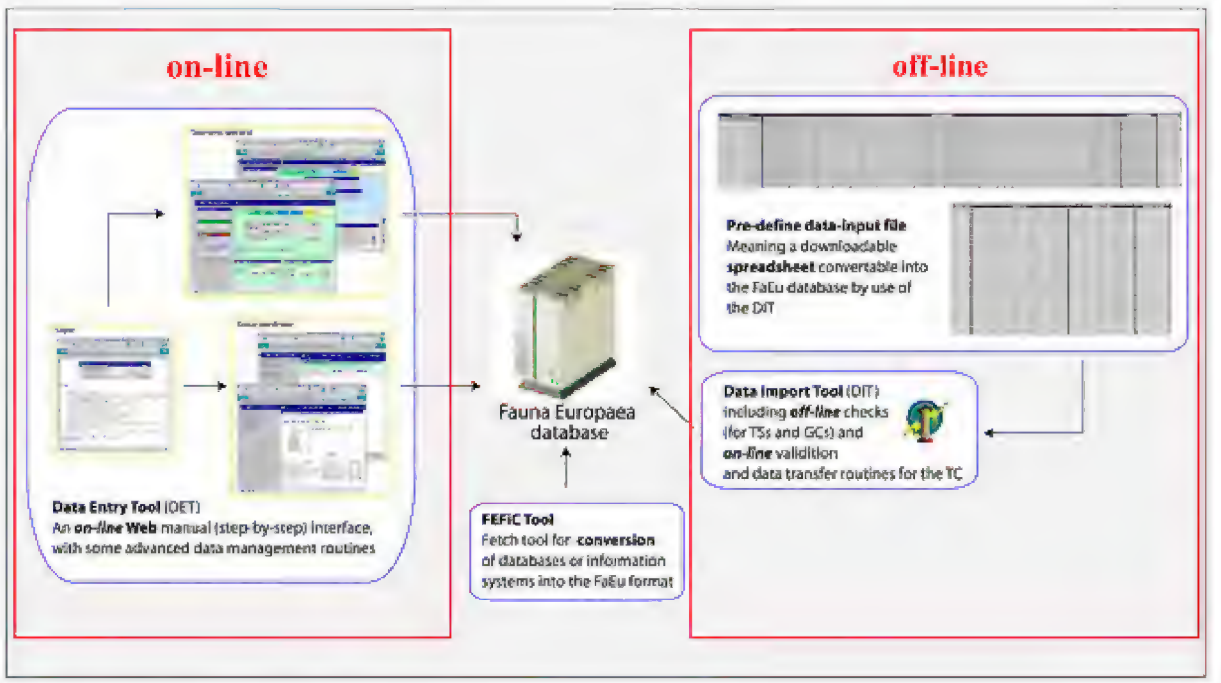


Figure 3.

Fauna Europaea on-line (browser interfaces) and off-line (spreadsheets) data entry tools.

Data set. The Fauna Europaea basic data set consists of: accepted (sub)species names (including authorship), synonyms (including authorship), taxonomic hierarchy / classification, misapplied names (including misspellings and alternative taxonomic views), homonym annotations, expert details, European distribution (at country level), Global

distribution (only for European species), taxonomic reference (optional), and occurrence reference (optional).

**Funding:** Fauna Europaea was funded by the European Commission under the Fifth Framework Programme and contributed to the Support for Research Infrastructures work programme with Thematic Priority Biodiversity (EVR1-1999-20001) for a period of four years (1 March 2000 - 1 March 2004), including a short 'NAS extension', allowing EU candidate accession countries to participate. Follow-up support was given by the EC-FP5 EuroCAT project (EVR1-CT-2002-20011), by the EC-FP6 ENBI project (EVK2-CT-2002-20020), by the EC-FP6 EDIT project (GCE 018340), by the EC-FP7 PESI project (RI-223806) and by the EC-FP7 ViBRANT project (RI-261532). Continuing management and hosting of the Fauna Europaea services was supported by the University of Amsterdam (Zoological Museum Amsterdam) and SARA/Vancis. Recently the hosting of Fauna Europaea was taken over by the Museum für Naturkunde in Berlin, supported by the EC-FP7 EU BON project (grant agreement №308454).

## Sampling methods

**Study extent:** See spatial coverage and geographic coverage descriptions.

**Sampling description:** Fauna Europaea data have been assembled by principal taxonomic experts, based on their individual expertise, including literature study, collection research, and field observations. No less than 476 experts contributed taxonomic and/or faunistic information for Fauna Europaea. The vast majority of the experts are from Europe (including EU non-member states). As a unique feature, Fauna Europaea funds were set aside for paying/compensating for the work of taxonomic specialists and group coordinators (around five Euro per species).

To facilitate data transfer and data import, sophisticated on-line (web interfaces) and off-line (spreadsheets) data-entry routines have been built, well integrated within an underlying central Fauna Europaea transaction database (see Fig. 3). This includes advanced batch data import routines and utilities to display and monitor the data processing within the system. In retrospect, it seems that the off-line submission of data was probably the best for bulk import during the project phase, while the on-line tool was preferred to enter modifications in later versions. This system works well until it supposed replacement in 2013.

A first release of the Fauna Europaea index via the web-portal has been presented at 27$^{th}$ of September 2004. The most recent release (version 2.6.2) was launched at 29 August 2013. An overview of Fauna Europaea releases can be found here: http://www.faunaeur.org/about_fauna_versions.php.

**Quality control:** Fauna Europaea data are unique in a sense that they are fully expert based. Selecting leading experts for all groups included a principal assurance of the systematic reliability and consistency of the Fauna Europaea data.

Further all Fauna Europaea data sets are intensively reviewed at regional and thematic validation meetings, at review sessions on taxonomic symposia (for some groups), by Fauna Europaea Focal Points (during the FaEu-NAS and PESI projects) and by various end-users sending annotations using the web form at the web-portal. Additional validation on gaps and correct spelling was effected at the validation office in Paris.

In conclusion, we expect to get taxonomic data for 99.3% of the known European fauna. The faunistic coverage is not quite as good, but is nevertheless 90-95% of the total fauna. Recognised gaps in Coleoptera includes some tribes of Staphylinidae, some minor tribes of Curculionidae, and a few minor families of Polyphaga, chiefly in SE Europe and in European Russia.

Checks on technical and logical correctness of the data have been implemented in the data entry tools, including around 50 "Taxonomic Integrity Rules". This validation tool proved to be of huge value for both the experts and project management, and significantly contribute(d) to preparation of a remarkably clean and consistent data set.

This thorough reviewing makes Fauna Europaea the most scrutinised data set in its domain.

**Step description:** By evaluating team structure and life cycle procedures (data-entry, validation, updating, etc.), clear definitions of roles of users and user-groups, according to the taxonomic framework were established, including ownership and read and writes privileges, and their changes during the project life-cycle. In addition, guidelines on common data exchange formats and codes have been issued (see also the 'Guidelines for Experts' document).

## Geographic coverage

**Description:** Species and subspecies distributions in Fauna Europaea are registered at least a country level, meaning political countries. For this purpose the FaEu geographical system basically follows the TDWG standards. The covered area includes the European mainland (Western Palearctic), plus the Macaronesian islands (excl. Cape Verde Islands), Cyprus, Franz Josef Land and Novaya Zemlya. Western Kazakhstan and the Caucasus are excluded (see Fig. 2).

The focus is on species (or subspecies) of European multicellular animals of terrestrial and freshwater environments. Species in brackish waters, occupying the marine/freshwater or marine/terrestrial transition zones, are generally excluded.

**Coordinates:** Mediterranean (N 35°) and Arctic Islands (N 82°) Latitude; Atlantic Ocean (Mid-Atlantic Ridge) (W 30°) and Ural (E 60°) Longitude.

## Taxonomic coverage

**Description:** The Fauna Europaea database contains the scientific names of all living European lands and freshwater animal species, including numerous infra-groups and synonyms. More details about the conceptual background of Fauna Europaea and standards followed are described in the project description papers (Figs 4, 5, 6, 7, 8, 9).

Figure 4.

*Scarites buparius* (Forster, 1771) – Carabidae – photo by Paolo Audisio

Figure 5.

*Rosalia alpina* (Linnaeus, 1758) – Cerambycidae – photo by Paolo Audisio

Figure 6.

*Amphotis marginata* (Fabricius, 1781) – Nitidulidae – photo by Christoph Benisch – www.kerbtier.de

Figure 7.

*Cucujus haematodes* Erichson, 1845 – Cucujidae – photo by Antonio Mazzei

Figure 8.

*Temnochila caerulea* (Olivier 1790) – Trogossitidae – photo by Antonio Mazzei

Figure 9.

*Meloe decorus* Brandt & Erichson, 1832 – Meloidae – photo by Christoph Benisch – www.kerbtier.de

This data paper covers the Coleoptera content of Fauna Europaea, including 80 Families 12,425 species, 3,663 subspecies and 6,660 (sub)species synonyms. Higher ranks are given below, the species list can be downloaded from the Fauna Europaea portal (see: Data resources).

## Taxa included:

| Rank | Scientific Name |
|---|---|
| kingdom | Animalia |
| subkingdom | Eumetazoa |
| phylum | Arthropoda |
| subphylum | Hexapoda |
| class | Insecta |
| order | Coleoptera |
| suborder | Adephaga |
| suborder | Archostemata |
| suborder | Myxophaga |
| suborder | Polyphaga |
| infraorder | Bostrichiformia |
| infraorder | Cucujiformia |
| superfamily | Bostrichoidea |
| superfamily | Caraboidea |
| superfamily | Chrysomeloidea |
| superfamily | Clavicornia |
| superfamily | Cleroidea |
| superfamily | Cucujoidea |
| superfamily | Cupedoidea |
| superfamily | Dascilloidea |
| superfamily | Dermestoidea |
| superfamily | Derodontoidea |
| superfamily | Heteromera |
| superfamily | Lymexyloidea |
| superfamily | Sphaeriusoidea |
| superfamily | Tenebrionoidea |
| family | Acanthocnemidae |
| family | Aderidae |
| family | Alexiidae |

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| family | Anobiidae |
| family | Anthicidae |
| family | Biphyllidae |
| family | Boridae |
| family | Bostrichidae |
| family | Carabidae |
| family | Cerambycidae |
| family | Cerylonidae |
| family | Chrysomelidae |
| family | Ciidae |
| family | Clambidae |
| family | Cleridae |
| family | Coccinellidae |
| family | Colydiidae |
| family | Corylophidae |
| family | Crowsoniellidae |
| family | Cryptophagidae |
| family | Cucujidae |
| family | Cybocephalidae |
| family | Dascillidae |
| family | Dasytidae |
| family | Dermestidae |
| family | Derodontidae |
| family | Diphyllidae |
| family | Dytiscidae |
| family | Scirtidae |
| family | Endecatomidae |
| family | Endomychidae |
| family | Erotylidae |
| family | Eucinetidae |
| family | Gietellidae |

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| family | Gyrinidae |
| family | Haliplidae |
| family | Hydroscaphidae |
| family | Hygrobiidae |
| family | Jacobsoniidae |
| family | Kateretidae |
| family | Laemophloeidae |
| family | Lagriidae |
| family | Languriidae |
| family | Latridiidae |
| family | Lyctidae |
| family | Lymexylidae |
| family | Melandryidae |
| family | Meloidae |
| family | Melyridae |
| family | Micromalthidae |
| family | Monotomidae |
| family | Mordellidae |
| family | Mycetophagidae |
| family | Mycteridae |
| family | Nitidulidae |
| family | Nosodendridae |
| family | Noteridae |
| family | Oedemeridae |
| family | Passandridae |
| family | Phalacridae |
| family | Phloeostichidae |
| family | Phloiophilidae |
| family | Prionoceridae |
| family | Prostomidae |
| family | Pyrochroidae |

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| family | Pythidae |
| family | Rhipiceridae |
| family | Rhipiphoridae |
| family | Ripiphoridae |
| family | Salpingidae |
| family | Scirtidae |
| family | Scraptiidae |
| family | Serropalpidae |
| family | Silvanidae |
| family | Sphaeriusidae |
| family | Sphaerosomatidae |
| family | Sphindidae |
| family | Stenotrachelidae |
| family | Tenebrionidae |
| family | Tetratomidae |
| family | Thanerocleridae |
| family | Trachypachidae |
| family | Trogossitidae |
| family | Zopheridae |
| subfamily | Agabinae |
| subfamily | Agleninae |
| subfamily | Agnathinae |
| subfamily | Alfieriellinae |
| subfamily | Alleculinae |
| subfamily | Alticinae |
| subfamily | Anamorphinae |
| subfamily | Anaspidinae |
| subfamily | Anobiinae |
| subfamily | Anthicinae |
| subfamily | Apotominae |
| subfamily | Atomariinae |

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| subfamily | Bergininae |
| subfamily | Bostrichinae |
| subfamily | Brachininae |
| subfamily | Broscinae |
| subfamily | Bruchinae |
| subfamily | Calopodinae |
| subfamily | Calyptomerinae |
| subfamily | Carabinae |
| subfamily | Carpophilinae |
| subfamily | Cassidinae |
| subfamily | Cerambycinae |
| subfamily | Ceryloninae |
| subfamily | Chaetomalachinae |
| subfamily | Chilocorinae |
| subfamily | Chlaeniinae |
| subfamily | Chrysomelinae |
| subfamily | Cicindelinae |
| subfamily | Cillaeinae |
| subfamily | Clambinae |
| subfamily | Clerinae |
| subfamily | Coccidulinae |
| subfamily | Coelometopinae |
| subfamily | Colydiinae |
| subfamily | Colymbetinae |
| subfamily | Copelatinae |
| subfamily | Corticariinae |
| subfamily | Corylophinae |
| subfamily | Criocerinae |
| subfamily | Cryptarchinae |
| subfamily | Cryptocephalinae |
| subfamily | Cryptophaginae |

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| subfamily | Cryptophaginae |
| subfamily | Cryptophilinae |
| subfamily | Cyclosominae |
| subfamily | Dacninae |
| subfamily | Danaceinae |
| subfamily | Dascillinae |
| subfamily | Dasytinae |
| subfamily | Diaperinae |
| subfamily | Dinoderinae |
| subfamily | Donaciinae |
| subfamily | Dorcatominae |
| subfamily | Dryophilinae |
| subfamily | Dryptinae |
| subfamily | Dytiscinae |
| subfamily | Elaphrinae |
| subfamily | Encaustinae |
| subfamily | Endomychinae |
| subfamily | Enopliinae |
| subfamily | Epilachninae |
| subfamily | Epuraeinae |
| subfamily | Ernobiinae |
| subfamily | Esarcinae |
| subfamily | Eucradinae |
| subfamily | Eumolpinae |
| subfamily | Eustrophinae |
| subfamily | Euxestinae |
| subfamily | Galerucinae |
| subfamily | Gibbiinae |
| subfamily | Gyrininae |
| subfamily | Hallomeninae |
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| subfamily | Hispinae |
| subfamily | Holoparamecinae |
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| subfamily | Hypocoprinae |
| subfamily | Korynetinae |
| subfamily | Laccophilinae |
| subfamily | Lagriinae |
| subfamily | Lamiinae |
| subfamily | Lamprosomatinae |
| subfamily | Latridiinae |
| subfamily | Lebiinae |
| subfamily | Leiestinae |
| subfamily | Lepturinae |
| subfamily | Licininae |
| subfamily | Lissodeminae |
| subfamily | Loricerinae |
| subfamily | Lycoperdininae |
| subfamily | Lyctinae |
| subfamily | Macratriinae |
| subfamily | Malachiinae |
| subfamily | Melaeninae |
| subfamily | Meligethinae |
| subfamily | Meloinae |
| subfamily | Merophysiinae |
| subfamily | Mesocoleopodinae |
| subfamily | Murmidiinae |
| subfamily | Mycetaeinae |
| subfamily | Mycetophaginae |
| subfamily | Nacerdinae |
| subfamily | Nebriinae |
| subfamily | Necydalinae |

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| subfamily | Nemognathinae |
| subfamily | Nitidulinae |
| subfamily | Noterinae |
| subfamily | Odacanthinae |
| subfamily | Oedemerinae |
| subfamily | Omophroninae |
| subfamily | Oodinae |
| subfamily | Orsodacninae |
| subfamily | Ortaliinae |
| subfamily | Orthoperinae |
| subfamily | Palorinae |
| subfamily | Panagaeinae |
| subfamily | Parandrinae |
| subfamily | Patrobinae |
| subfamily | Paussinae |
| subfamily | Pedilinae |
| subfamily | Pelecotominae |
| subfamily | Peltinae |
| subfamily | Perigoninae |
| subfamily | Phalacrinae |
| subfamily | Phrenapatinae |
| subfamily | Pimeliinae |
| subfamily | Platyninae |
| subfamily | Pleganophorinae |
| subfamily | Polycaoninae |
| subfamily | Prioninae |
| subfamily | Promecognathinae |
| subfamily | Psoinae |
| subfamily | Psydrinae |
| subfamily | Pterostichinae |
| subfamily | Ptilininae |

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| subfamily | Ptilophorinae |
| subfamily | Ptininae |
| subfamily | Pyrochroinae |
| subfamily | Rhadalinae |
| subfamily | Rhysodinae |
| subfamily | Ripidiinae |
| subfamily | Ripiphorinae |
| subfamily | Rypobiinae |
| subfamily | Salpinginae |
| subfamily | Scaritinae |
| subfamily | Scraptiinae |
| subfamily | Scymninae |
| subfamily | Setariolinae |
| subfamily | Siagoninae |
| subfamily | Spondylidinae |
| subfamily | Steropinae |
| subfamily | Sticholotidinae |
| subfamily | Synetinae |
| subfamily | Tarsosteninae |
| subfamily | Telmatophilinae |
| subfamily | Tenebrioninae |
| subfamily | Tetratominae |
| subfamily | Tillinae |
| subfamily | Tomoderinae |
| subfamily | Toraminae |
| subfamily | Trachypachinae |
| subfamily | Trechinae |
| subfamily | Tritominae |
| subfamily | Trogossitinae |
| subfamily | Vesperinae |
| subfamily | Xenoscelinae |

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| subfamily | Xyletininae |
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| subfamily | Zopherinae |
| tribe | Abacetini |
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| tribe | Alfieriellini |
| tribe | Alphitobiini |
| tribe | Amauronioidini |
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| tribe | Broscini |
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| tribe | Cnemeplatiini |
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| tribe | Crypticini |
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| tribe | Cychrini |
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| tribe | Elenophorini |
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| tribe | Gyrinini |
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| tribe | Mycetophagini |
| tribe | Mylabrini |
| tribe | Myrmechixenini |
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| tribe | Nemognathini |
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| tribe | Noterini |
| tribe | Notiophilini |
| tribe | Notoxini |
| tribe | Noviini |
| tribe | Odacanthini |
| tribe | Oedemerini |
| tribe | Omophronini |
| tribe | Omphreini |
| tribe | Oodini |
| tribe | Opatrini |
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| tribe | Pachymerini |
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| tribe | Patrobini |
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| tribe | Platynaspidini |
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| tribe | Pogonini |
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| tribe | Serangiini |
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| tribe | Stenosini |
| tribe | Stenostomatini |
| tribe | Stethorini |
| tribe | Sticholotidini |
| tribe | Stomini |
| tribe | Strongyliini |
| tribe | Stylosomini |
| tribe | Telmatophilini |
| tribe | Tenebrionini |
| tribe | Tentyriini |
| tribe | Teplinini |
| tribe | Tetrabrachini |
| tribe | Thaneroclerini |
| tribe | Trachypachini |
| tribe | Trachyscelini |
| tribe | Trechini |
| tribe | Triboliini |
| tribe | Trogoxylini |
| tribe | Typhaeini |
| tribe | Tytthaspididini |

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| tribe | Ulomini |
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| tribe | Zabrini |
| tribe | Zophosini |
| tribe | Zuphiini |
| subtribe | Acanthoscelidina |
| subtribe | Aepina |
| subtribe | Amblicerina |
| subtribe | Amblystomina |
| subtribe | Anillina |
| subtribe | Aptinina |
| subtribe | Atranopsina |
| subtribe | Aulacophorina |
| subtribe | Bembidiina |
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| subtribe | Bruchina |
| subtribe | Calathina |
| subtribe | Calosomatina |
| subtribe | Carabina |
| subtribe | Caryedonina |
| subtribe | Chlaeniina |
| subtribe | Cicindelina |
| subtribe | Clinidiina |
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| subtribe | Cymindidina |
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| subtribe | Lionychina |
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| subtribe | Megacephalina |
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| subtribe | Pheropsophina |
| subtribe | Poecilina |
| subtribe | Pseudomasoreina |
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| subtribe | Pterostichina |
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| subtribe | Rhaebina |
| subtribe | Rhysodina |
| subtribe | Scaritina |
| subtribe | Sphodrina |
| subtribe | Synuchina |
| subtribe | Tachyina |
| subtribe | Trechina |
| subtribe | Trechodina |
| subtribe | Trichina |
| family | Byturidae |

## Temporal coverage

**Living time period:** Currently living.

**Notes:** Currently living multicellular, terrestrial and freshwater animals in stable populations, largely excluding (1) rare / irregular immigrants, (2) alien / invasive species, (3) accidental or deliberate releases of exotic (pet)species, (4) domesticated animals, (5) non-native species imported and released for bio-control or (6) non-native species largely confined to hothouses.

## Usage rights

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## Data resources

**Data package title:** Fauna Europaea - Coleoptera - 2

**Resource link:** http://www.faunaeur.org/Data_papers/FaEu_Coleoptera-2_2.6.2.zip

**Alternative identifiers:** http://www.faunaeur.org/experts.php?id=18

**Number of data sets:** 2

**Data set name:** Fauna Europaea - Coleoptera 2 (excl...) version 2.6.2 - species

**Character set:** UTF-8

**Download URL:** http://www.faunaeur.org/Data_papers/FaEu_Coleoptera-2_2.6.2.zip

**Data format:** CSV

| Column label | Column description |
|---|---|
| datasetName | The name identifying the data set from which the record was derived (http://rs.tdwg.org/dwc/terms/datasetName). |
| version | Release version of data set. |
| versionIssued | Issue data of data set version. |
| rights | Information about rights held in and over the resource (http://purl.org/dc/terms/rights). |
| rightsHolder | A person or organization owning or managing rights over the resource (http://purl.org/dc/terms/rightsHolder). |

| | |
|---|---|
| accessRights | Information about who can access the resource or an indication of its security status (http://purl.org/dc/terms/accessRights). |
| taxonID | An identifier for the set of taxon information (http://rs.tdwg.org/dwc/terms/taxonID) |
| parentNameUsageID | An identifier for the name usage of the direct parent taxon (in a classification) of the most specific element of the scientificName (http://rs.tdwg.org/dwc/terms/parentNameUsageID). |
| scientificName | The full scientific name, with authorship and date information if known (http://rs.tdwg.org/dwc/terms/scientificName). |
| acceptedNameUsage | The full name, with authorship and date information if known, of the currently valid (zoological) taxon (http://rs.tdwg.org/dwc/terms/acceptedNameUsage). |
| originalNameUsage | The original combination (genus and species group names), as firstly established under the rules of the associated nomenclaturalCode (http://rs.tdwg.org/dwc/terms/originalNameUsage). |
| family | The full scientific name of the family in which the taxon is classified (http://rs.tdwg.org/dwc/terms/family). |
| familyNameId | An identifier for the family name. |
| genus | The full scientific name of the genus in which the taxon is classified (http://rs.tdwg.org/dwc/terms/genus). |
| subgenus | The full scientific name of the subgenus in which the taxon is classified. Values include the genus to avoid homonym confusion (http://rs.tdwg.org/dwc/terms/subgenus). |
| specificEpithet | The name of the first or species epithet of the scientificName (http://rs.tdwg.org/dwc/terms/specificEpithet). |
| infraspecificEpithet | The name of the lowest or terminal infraspecific epithet of the scientificName, excluding any rank designation (http://rs.tdwg.org/dwc/terms/infraspecificEpithet ). |
| taxonRank | The taxonomic rank of the most specific name in the scientificName (http://rs.tdwg.org/dwc/terms/infraspecificEpithet). |
| scientificNameAuthorship | The authorship information for the scientificName formatted according to the conventions of the applicable nomenclaturalCode (http://rs.tdwg.org/dwc/terms/scientificNameAuthorship). |
| authorName | Author name information |
| namePublishedInYear | The four-digit year in which the scientificName was published (http://rs.tdwg.org/dwc/terms/namePublishedInYear). |
| Brackets | Annotation if authorship should be put between parentheses. |

| | |
|---|---|
| nomenclaturalCode | The nomenclatural code under which the scientificName is constructed (http://rs.tdwg.org/dwc/terms/nomenclaturalCode). |
| taxonomicStatus | The status of the use of the scientificName as a label for a taxon (http://rs.tdwg.org/dwc/terms/taxonomicStatus). |
| resourceDescription | An account of the resource, including a data-paper DOI (http://purl.org/dc/terms/description) |

**Data set name:** Fauna Europaea - Coleoptera 2 (excl...) version 2.6.2 - hierarchy

**Character set:** UTF-8

**Download URL:** http://www.faunaeur.org/Data_papers/FaEu_Coleoptera-2_2.6.2.zip

**Data format:** CSV

| Column label | Column description |
|---|---|
| datasetName | The name identifying the data set from which the record was derived (http://rs.tdwg.org/dwc/terms/datasetName). |
| version | Release version of data set. |
| versionIssued | Issue data of data set version. |
| rights | Information about rights held in and over the resource (http://purl.org/dc/terms/rights). |
| rightsHolder | A person or organization owning or managing rights over the resource (http://purl.org/dc/terms/rightsHolder). |
| accessRights | Information about who can access the resource or an indication of its security status (http://purl.org/dc/terms/accessRights). |
| taxonName | The full scientific name of the higher-level taxon |
| scientificNameAuthorship | The authorship information for the scientificName formatted according to the conventions of the applicable nomenclaturalCode (http://rs.tdwg.org/dwc/terms/scientificNameAuthorship). |
| taxonRank | The taxonomic rank of the most specific name in the scientificName (http://rs.tdwg.org/dwc/terms/infraspecificEpithet). |
| taxonID | An identifier for the set of taxon information (http://rs.tdwg.org/dwc/terms/taxonID) |
| parentNameUsageID | An identifier for the name usage of the direct parent taxon (in a classification) of the most specific element of the scientificName (http://rs.tdwg.org/dwc/terms/parentNameUsageID). |
| resourceDescription | An account of the resource, including a data-paper DOI (http://purl.org/dc/terms/description) |

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## Author contributions

Authors Paolo Audisio and Yde de Jong organized and wrote the main text of the paper, which has been reviewed, corrected and improved by all other co-authors.

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# Supplementary material

## Suppl. material 1: FaEu Coleoptera 2 stats

**Authors:** Yde de Jong & Paolo Audisio
**Data type:** png
**Brief description:** This is a high-resolution version of Figure 3.
**Filename:** FaEu_Coleoptera_2_stats.png - Download file (1016.49 kb)